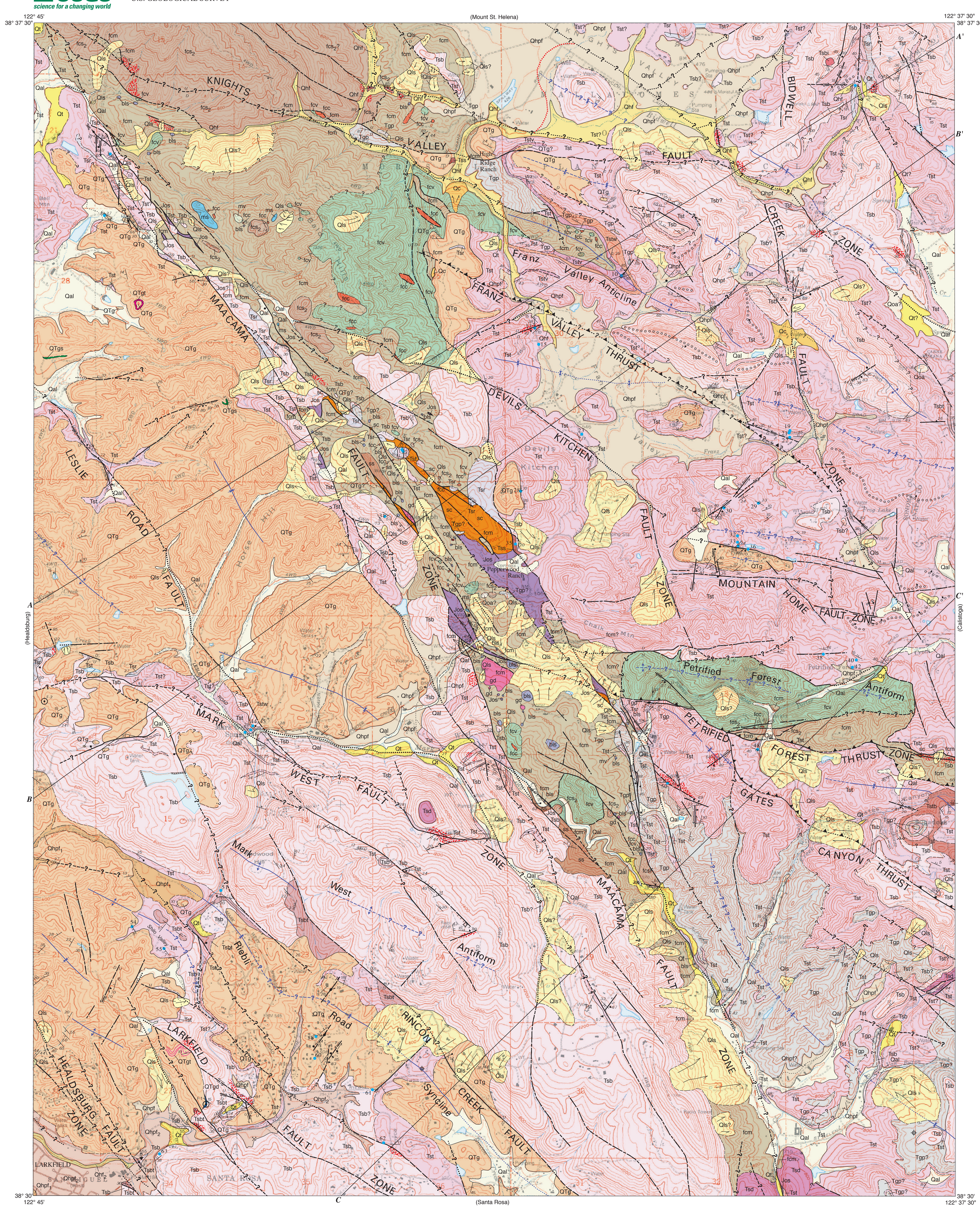
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SCIENTIFIC INVESTIGATIONS MAP 2858
SHEET 1 of 2
Pamphlet accompanies map



Base from U.S. Geological Survey, Mark West Springs, 1993
Universal Transverse Mercator projection

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 2004

MAP LOCATION

The geology presented here was mapped by R.J. McLaughlin mainly between February 1999 and October 2002, with some earlier reconnaissance work in 1996-1998. The geology of the northeast side of Franz Valley and High Ridge Ranch area was mapped by McLaughlin and W.H. Wright (Sonoma State University) in September 2001, with some of the mapping in that area modified from a Sonoma State University student mapping project (Kathleen Burnham, 1993), after field checking by McLaughlin and Wright. The southwest corner of the quadrangle northeast of Larkfield is compiled in-part from reconnaissance mapping by D.L. Wagner (California Geological Survey) in 1978.

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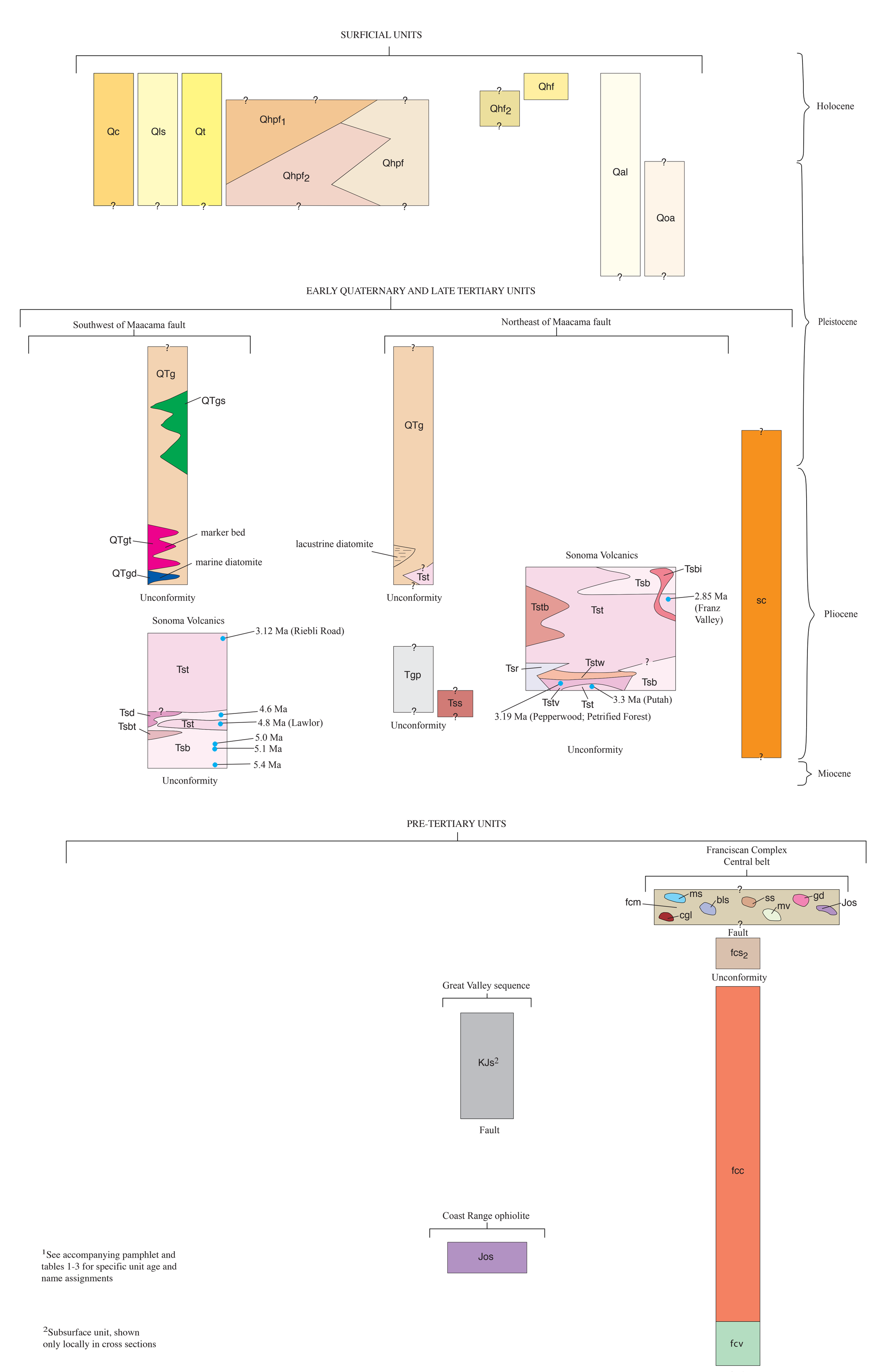
CORRELATION OF MAP UNITS[1]



[1]See accompanying pamphlet and tables 1-3 for specific unit age and name assignments

[2]Subsurface unit, shown only locally in cross sections

DESCRIPTION OF MAP UNITS

SURFICIAL UNITS

Qhf **Alluvial fan and fluvial terrace deposits, undivided (Holocene)**—Gravel, sand, and silt derived primarily from Pleistocene and older sedimentary and igneous units.

Qhf_2 **Old Holocene alluvial fan and fluvial terrace deposits (Holocene?)**—Incise older Holocene and some pre-Holocene alluvial deposits

Qhpf **Alluvial fan and terrace deposits, undivided (Holocene? and (or) Pleistocene)**

$Qhpf_1$ **Younger alluvial fans and terrace deposits (Holocene? and (or) Pleistocene)**

$Qhpf_2$ **Older alluvial fan and terrace deposits (Holocene? and (or) Pleistocene)**

Qls **Landslide deposits (Holocene and Pleistocene)**—Deposits vary from intact slabs of rock to unconsolidated rock, soil, and colluvium that have been displaced down-slope by gravitational processes. Arrows indicate direction of movement

Qt **Alluvial deposits, undivided (Holocene and Pleistocene)**—Include Holocene and Pleistocene alluvial fan and terrace deposits

Qal **Alluvial deposits (Holocene and (or) Pleistocene)**—Undivided Quaternary alluvium

Qc **Colluvium (Holocene and (or) Pleistocene)**—Unconsolidated soil and rock debris generally transported down-slope by gravitational processes. Arrows indicate direction of movement or creep

Qoa **Older alluvial deposits, undivided (Pleistocene)**—Uplifted or dissected older alluvium

EARLY QUATERNARY AND LATE TERTIARY UNITS

Sedimentary Deposits

QTg **Fluvial and lacustrine deposits (early Pleistocene and Pliocene)**—Gravel, sandstone, siltstone, mudstone, lacustrine diatomite, silicic tuff (QTgt), and siltstone (QTgs). Include obsidian clast-bearing gravels previously assigned to Glen Ellen and Huichica Formations. Southwest of Maacama Fault, unit unconformably overlies and is derived from pre-Tertiary basement and Tertiary volcanics. Northeast of Maacama Fault unit unconformably overlies pre-Tertiary basement, Sonoma Volcanics of the Petrified Forest and Franz Valley, and fluvial and lacustrine deposits of Humbug Creek (Tgp). A thin marine diatomite bed (QTgd) intercalated at base of formation in the southwest corner of the quadrangle may be correlative to the marine Wilson Grove Formation of Fox (1983)

QTgs **Siltstone marker beds**—Locally intercalated in gravels

QTgt **Siliceous tuff marker bed**

QTgd **Marine diatomite**

sc **Silica carbonate rock (Pleistocene and Pliocene)**—Hydrothermally altered ultramafic rocks, composed of quartz and magnesium carbonate mineral assemblages, commonly associated with mercury and other epithermal base metal sulfide occurrences (Ag, Au, Pb, Zn, Cu). Mineralization ages generally correspond with, but are somewhat younger than, ages of associated Quaternary and Tertiary volcanic rocks

Tgp **Fluvial and lacustrine deposits of Humbug Creek (Pliocene)**—Gravel, sandstone, siltstone, mudstone, and nonmarine diatomite. Unit is locally interleaved with siliceous tuff of Sonoma Volcanics (Tst). Unit is present northeast of the Maacama Fault Zone where it underlies and interfingers with the lower part of Sonoma Volcanics of Petrified Forest and Franz Valley. Gravel is predominantly derived from pre-Tertiary basement with only rare obsidian clasts in lower part. Higher in the section, unit includes coarse, Tertiary volcanics-derived gravel. Base of unit not exposed

Tss **Sandstone (late Pliocene or older)**—Friable, lithic, gravelly sandstone, locally mapped beneath, or interbedded in, lower part of fluvial and lacustrine deposits of Humbug Creek (Tgp) along the northeast side of the Maacama Fault west of Franz Valley. Sandstone is largely derived from underlying Franciscan Complex basement. Upper beds of unit, however, include tuffaceous sandstone, siltstone, and gravel derived from Tertiary volcanics

Sonoma Volcanics (Pliocene and Miocene)—Rhyolitic to dacitic ash-flow and air-fall tuff, andesitic water-lain tuff, and rhyolitic to basaltic flows and flow breccia.

Tsd **Dacitic flows**—Mapped locally in upper part of volcanic sequence and undated dacite about 2 km east-southeast of Mark West Springs

Tsr **Rhyolitic and rhyodacitic flows and intrusive rocks**—Granular porphyritic to aphanitic, with phenocrysts of quartz and plagioclase, in part coeval with ash-flow tuff (Tst) mapped locally. Include the rhyolite of Pepperwood Ranch, radiometrically dated at 3.19±0.02 Ma ($^{40}Ar/^{39}Ar$)

Tst **Rhyolite pumiceous ash-flow and minor air fall tuff**—Northeast of the Maacama Fault, includes the ash-flow tuff of Franz Valley, radiometrically dated at 2.85 m.y. ($^{40}Ar/^{39}Ar$); the ash-flow tuff of the Petrified Forest, which contains numerous large petrified redwood trees and other fossil flora; and the Putah Tuff, with radiometric ages of 3.3 to 3.4 m.y. (K-Ar). Southwest of the Maacama Fault, unit includes the tuff of Riebli Road, radiometrically dated at 3.12±0.03 m.y. ($^{40}Ar/^{39}Ar$). Unit locally includes undivided rhyolitic to dacitic flows

Tstv **Rhyolitic to rhyodacitic vitrophyre**—Locally mapped in Franz Valley and High Ridge Ranch area and radiometrically dated at 3.19±0.04 Ma ($^{40}Ar/^{39}Ar$)

Tstw **Crystal-rich rhyolitic to rhyodacitic welded tuff**—Locally mapped in Franz Valley area and along Leslie Road

Tstb **Breccia**—Mapped locally northeast of the Maacama Fault in lower ash-flow tuff sequence of the Petrified Forest and Franz Valley. Breccia includes angular, meter- to boulder-scale laharic blocks of basalt, andesite, and vitric porphyritic rhyodacite in a lithic rhyodacite ash flow tuff matrix

Tsb **Andesite, basaltic andesite, and basalt**—Largely subaerial andesitic to basaltic flows, flow breccia and tuff breccia, local waterlain andesitic tuff, and minor dacitic ash-flow tuff. Northeast of the Healdsburg Fault and southwest of the Maacama Fault, includes basaltic rocks of Telegraph Hill area, radiometrically dated at 5.4±0.20 Ma ($^{40}Ar/^{39}Ar$); basalt along Mark West Springs Road, immediately northeast of Larkfield and the Healdsburg Fault, originally radiometrically dated by K-Ar methods (Fox and others, 1985a, b) at 8.9±4.5 m.y., but redated herein at 4.60±0.05 Ma ($^{40}Ar/^{39}Ar$); and basalt of Leslie Road, dated herein at 4.85±0.03 m.y. ($^{40}Ar/^{39}Ar$).

In the Franz Valley area northeast of the Maacama Fault, and on the southwest slope of Mt. St. Helena, andesite and basaltic andesite are intercalated in rhyodacite ash-flow tuff (Tst). Here andesite and basaltic andesite is hard, aphanitic to porphyritic, locally flow banded, with close-spaced platy partings parallel to flow structure

Tsbt **Andesitic tuff**—Mapped locally southwest of the Maacama fault, where tuff is fine-grained, waterlain, and intercalated in the upper part of basalt and andesite (Tsb)

Tsbi **Basaltic intrusive rocks (late Pliocene)**—Undated fine-grained basaltic rocks intruding basaltic andesites and siliceous ash-flow tuff, mapped locally northeast of Franz Valley

PRE-TERTIARY UNITS

Franciscan Complex (Upper Cretaceous to Lower Jurassic)—Central belt

fcm **Undifferentiated melange of the Central belt**—Largely penetratively sheared sandstone and argillite, with undivided blocks of varying lithology too small to map. Sheared boundaries of slabs and blocks in melange of Central belt are shown as contacts on map for legibility, except where boundary is modified by Pliocene and younger faults. Large slabs and blocks are mapped locally and described below.

ss **Sandstone and shale, undivided**—Lithic metasandstone and minor interbedded argillite, locally with abundant chert and mafic igneous detritus and with as much as 5 percent detrital K-feldspar (McLaughlin and Ohlin, 1984), reconstituted to Textural Zone 1 to 1+ (Blake and others, 1967). Locally conglomeratic. Sandstone generally contains incipiently developed pumpellyite + phengitic mica

cgl **Conglomerate**—Pebbly to bouldery, typically polymict

ms **Metasandstone**—Reconstituted to Textural Zone 2 (Blake and others, 1967) and containing incipient lawsonite ± sodic amphibole ± jadeite, tectonically derived from Eastern belt (Yolla Bolly terrane) of the Franciscan Complex. Locally includes minor intercalated metachert and (or) metabasalt (mv)

mv **Basaltic to felsic extrusive and intrusive volcanic or plutonic rocks**—Metamorphosed to greenschist and (or) blueschist grade, locally interlayered with metachert

gd **Blocks of gabbroic and diabasic rocks**—Metamorphosed to greenschist or blueschist grade, locally with cumulate texture, probably in-part derived from Coast Range ophiolite, mapped locally

Jos **Serpentinite**—Largely derived from the Coast Range ophiolite, enclosed by matrix of melange (fcm)

bls **Blueschist block**—Mafic to felsic igneous and pelagic rocks, metamorphosed to high blueschist grade. Includes eclogite and amphibolite-grade blocks partially retrograded to blueschist

fcs_2 **Sandstone, shale, and conglomerate**—Lithic metasandstone and argillite, commonly with abundant chert and mafic volcanic detritus and carbonized plant debris along bedding, reconstituted to Textural zone 1 to Textural Zone 1+ (Blake and others, 1967); generally contains incipiently developed pumpellyite, phengitic mica, and rarely lawsonite. Depositionally overlies radiolarian chert of Marin Headlands-Geysers terrane (McLaughlin and Ohlin, 1984; Murchey, 1984)

fcc **Radiolarian chert of Marin Headlands-Geysers terrane**—Red to green, locally tuffaceous, and in places depositional on, or interlayered with, basaltic volcanic rocks. Where section is complete, radiolarian assemblage is early Late Cretaceous (Cenomanian) to Early Jurassic (Pliensbachian) age (McLaughlin and Pessagno, 1978; Hagstrum and Murchey, 1993) and is depositionally overlain by terrigenous metasandstone and shale (fcs_2)

fcv **Basalt volcanic rocks**—Generally metamorphosed to low-greenschist grade, containing epidote and pumpellyite. Include basaltic rocks of Marin Headlands-Geysers terrane

Great Valley sequence (Cretaceous and Jurassic)

KJs **Shale and sandstone (Lower Cretaceous and late Jurassic)**—Dark-green to olive-gray shale, rhythmically interbedded basaltic sandstone, and (or) lithic to arkosic wacke and polymict, rounded pebble to boulder conglomerate. Rocks locally contain lower Cretaceous (Valanginian) to Late Jurassic (Tithonian) molluskan fauna (mostly *Buchia*) and microfossils (radiolaria and foraminifers) of late Jurassic (Tithonian) age. Unit present locally only in subsurface (see cross sections A-A' and B-B', sheet 2)

Coast Range ophiolite (Jurassic)

Jos **Serpentinized ultramafic rocks**—Predominantly noncumulate tectonitic harzburgite, dunite, and peridotite. Serpentine mineral assemblage is predominantly low-temperature mixture of lizardite and chrysotile. Includes minor cumulate ultramafic to gabbroic rocks locally

Contact—Dashed where approximately located; dotted where concealed; queried where uncertain

Concealed base of Sonoma Volcanics—Estimated location in Knights Valley

Fault—Dashed where approximately located or inferred; dotted where concealed; queried where uncertain

U D 60 57 **Normal fault**—Showing geometry of fault plane and sense of slip. Bar and ball on down-dropped block; U on upthrown block; D on down-dropped block where fault dip unknown. Arrows show direction of relative horizontal movement. Dip of fault plane shown by arrow normal to fault with dip amount indicated where known; arrow and number at angle to fault indicate rake of lineation; diamond astride fault indicates vertical dip

Thrust fault—Sawteeth on upper plate

Fault lineament—Inferred from linear features on aerial photography; dotted where projected beneath surficial deposits; queried where uncertain. Arrows show relative horizontal motion

Fault scarp—Showing fault line at base of scarp. Hachures point downscarp

Fold—Dashed where approximately located; dotted where concealed; queried where uncertain

Anticline

Syncline

65 **Overturned syncline**—Showing dip

55 **Minor syncline**—Showing bearing and plunge

Reservoir dam

Shear zone

Marker bed—Showing dip direction

Closed depression or sag pond

Strike and dip of beds

63 **Inclined**

42 **Inclined**—Top of beds known from local features

Vertical

59 **Approximate**—Determined by sighting from distant location; dip indicated where measured

Strike and dip of foliation in sheared or foliated rock

48 **Inclined**

Vertical or near vertical

18 **Strike and dip of volcanic flow unit**

Open pit, quarry, or glory hole

F-1 **Fossil locality**

21 **Radiometric dating and tephrochronology localities**—Numbers refer to figures 3*A*,*B* and tables 1-3

Spring

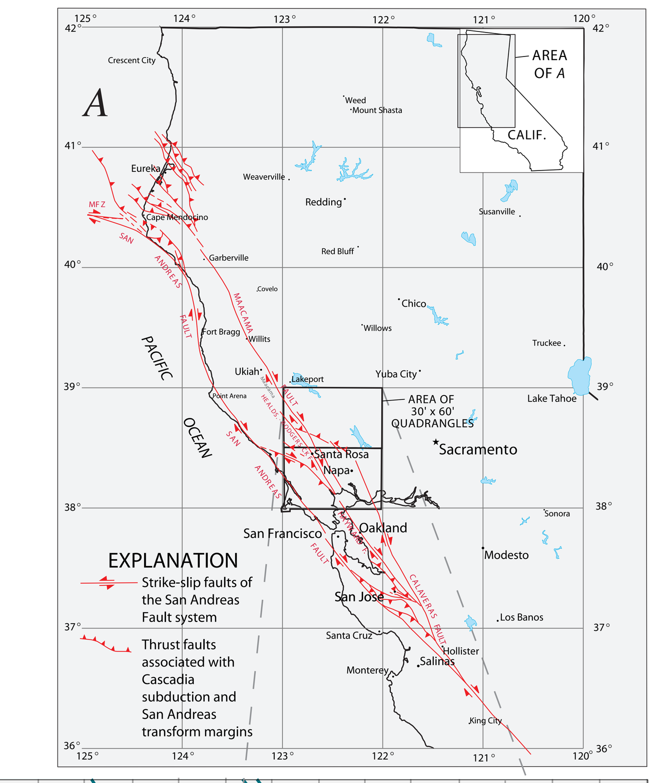
Thermal spring

Water well

Dry hole—Abandoned drill hole for water

Area of hydrothermal alteration

Landslide—Arrows indicate direction of movement



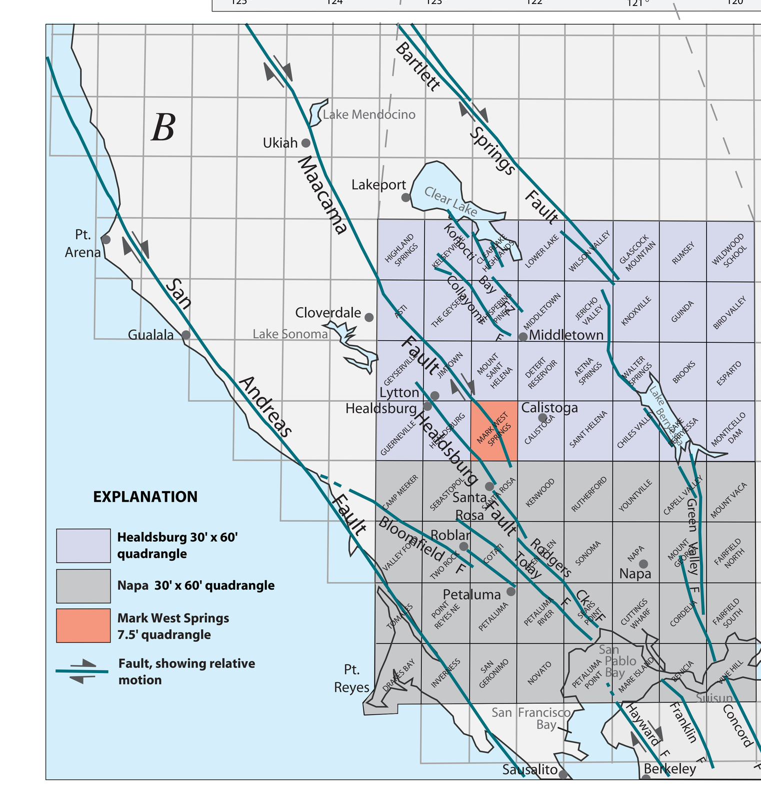


Figure 1. Maps showing location of Mark West Springs 7.5' quadrangle in northern part of San Francisco Bay Area, California. *A*. Major faults associated with San Andreas transform and Cascadia subduction margin. *B*. Location of Mark West Springs and other 7.5' quadrangles within Healdsburg and Napa 30' x 60' quadrangles and major Neogene faults. F, fault; FZ, fault zone.

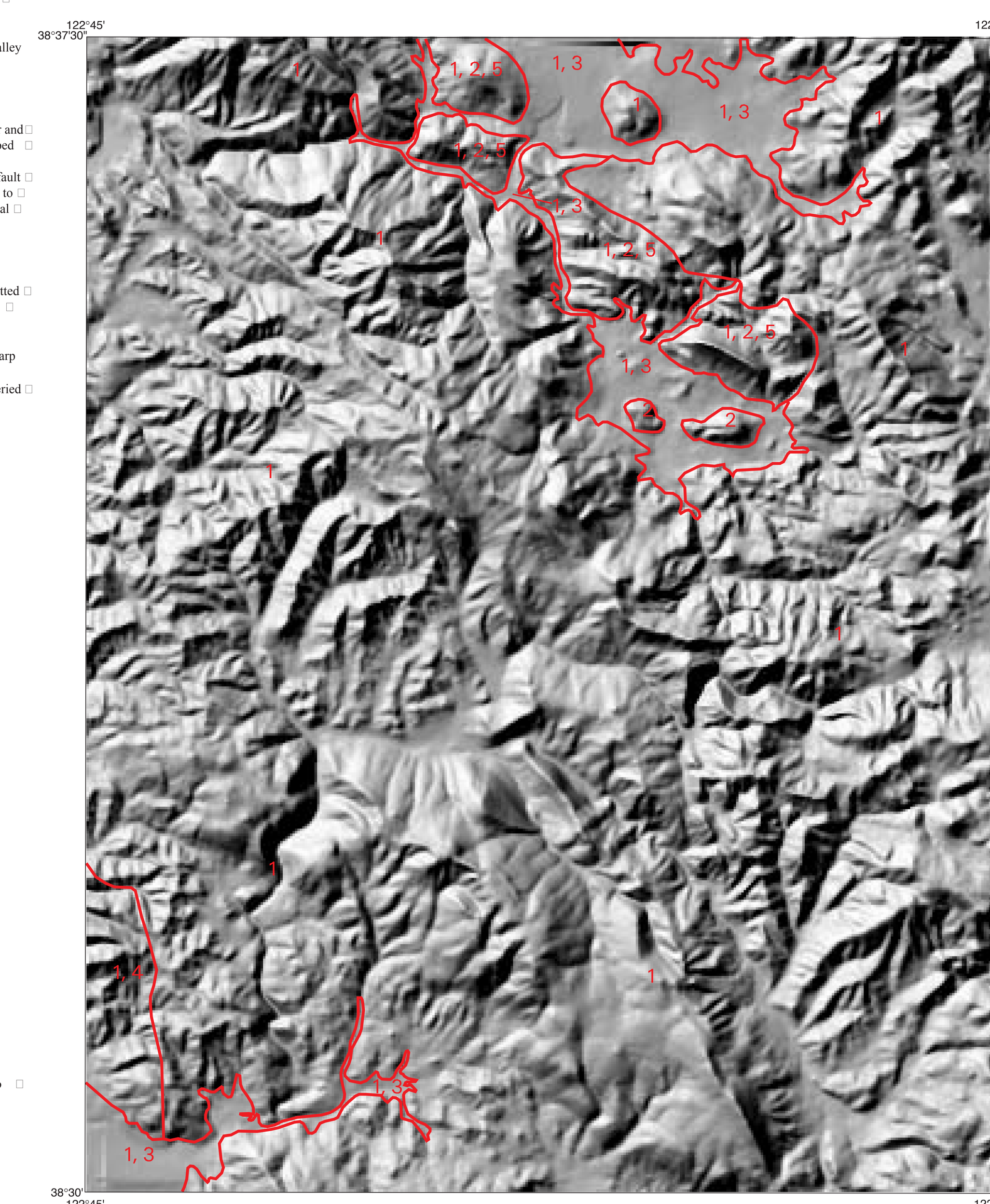


Figure 2. Sources of geologic mapping in the Mark West Springs 7.5' quadrangle. Mapping began in 1996 and ended in October 2002. The sources include: 1. R. J. McLaughlin, fieldwork, 1997 – 2002. 2. R. J. McLaughlin and W. H. Wright, field work in Franz Valley and vicinity, June 2000 and September 2001. 3. Quaternary geology locally compiled from Knudsen and others, 2000. 4. D. Wagner, fieldwork, May 1978. Field notes and mapping communicated to McLaughlin February 4, 2002. 5. K. Burnham, Sonoma State University, student field project for W. H. Wright, May 1993. Checked by McLaughlin and Wright, June 2000.

Geology, Tephrocronology, Radiometric Ages, and Cross Sections of the Mark West Springs 7.5' Quadrangle, Sonoma and Napa Counties, California

By
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